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GLASS SUBSTRATE PACKAGE

FIELD OF THE INVENTION

The present invention relates to a package in which a glass substrate is packed and sealed with a film, and more specifically, to a package in which a glass substrate to be used for a liquid crystal display or the like is packed and sealed with a film.

BACKGROUND OF THE INVENTION

To realize high quality of a display device such as a liquid crystal display (LCD), one of the greatest concerns is to eliminate scratches and dirt on surfaces of a glass substrate to be used for the display device as much as possible during transportation and storage thereof.

To address this problem, there have been several practical methods for transporting and storing the glass substrates. Such methods include a method of using a container provided with a plurality of grooves in which individual glass substrates are inserted, and a method of stacking a plurality of glass substrates each protected by a frame. In those methods, a gap filled with clean air is provided between each adjacent glass substrate. Therefore, it is possible to prevent scratches due to friction between each adjacent glass substrate and concurrently to reduce dirtying due to external dirt sources in the outside atmosphere.

However, the above methods of providing the gap between each adjacent glass substrate considerably limit the number of the glass substrates that can be stored in a space of a fixed size (i.e. stacking efficiency), and thus limit efficiency in transportation and storage of the glass substrates.

To improve the stacking efficiency of the glass substrates during transportation and storage thereof, there has been another practical method of alternately stacking a plurality of glass substrates and sheets of paper. In that method, however, a problem of what is called "surface yellowing" occurs because of chemical reaction between the sheets of paper and moisture in the atmosphere. In addition, dirtying of edge faces of each glass substrate cannot be eliminated in that method since the edge faces are exposed to the outer atmosphere.

To solve the problem of the surface yellowing, another method of stacking a plurality of glass substrates each having coating films such as polyethylene films attached to both surfaces thereof has also been used. When the coated glass substrates are stacked, a sheet of paper may be additionally inserted between the films to prevent the films from sticking to each other.

In the method of using the films, however, another problem has arisen. That is, residuals of the films remain sticking to the surfaces of the glass substrates even after removal of the films. Because of those residuals, it becomes indispensable to wash each glass substrate through a chemical washing process using detergent or the like after unpacking of the glass substrates and before processing them into products. Such a chemical washing process using the detergent or the like requires much time and large costs, and thus is a key factor which limits production efficiency of products such as LCDs.

In addition, the above method using the coating films does not solve the problem of dirtying of the edge faces. Further, in the case where the sheets of paper are additionally used, dirtying due to the sheets of paper cannot be totally eliminated, either.

On the other hand, Japanese Unexamined Patent Publication No. 11(1999)-1205 discloses a bag-like glass substrate package in which a single glass substrate is entirely packed. Upon transportation, a plurality of glass substrates each packed in the above way are stacked within a container.

Herein, the bag-like package is made of a laminated film, which is typically a laminated film consisting of an aluminum sheet sandwiched between a pair of polyethylene films.

Since the package as disclosed in Japanese Unexamined Patent Publication No. 11(1999)-1205 covers the entire surfaces of the glass substrate including the edge faces thereof, it is not required to further prevent contact of the glass substrate with the outer atmosphere by intentionally having the inner surfaces of the films stick to the surfaces of the glass substrate in the similar way as done in the above-described method of coating both surfaces of the glass substrate with the films. However, there is a possibility that rather unfavorable sticking occurs between the inner surfaces of the film and the surfaces of the glass substrate, particularly when a plurality of packed glass substrates are stacked within the container and the films are pressed against the surfaces of the glass substrates. That is, the method of Japanese Unexamined Patent Publication No. 11(1999)-1205 does not eliminate the possibility that residuals may remain on the surfaces of the glass substrates after unpacking thereof, and thus still require the chemical washing process that is costly and time-consuming. In this respect, Japanese Unexamined Patent Publication No. 11(1999)-1205 employs a technique of processing the inner surface of the film into an uneven surface with fine protrusions so that contact area between the film and the surface of the glass substrate is reduced. This may reduce the residuals to some degree, but still does not completely eliminate the need for a chemical washing process using a detergent or the like.

Further, in the case where a package covers the entire surfaces of the glass substrate including the edge faces thereof as is the case in Japanese Unexamined Patent Publication No. 11(1999)-1205, it is preferable to deaerate the inside volume of each package for several purposes including improvement of the efficiency in transportation and storage. However, when the film is such a one that requires the chemical washing process,

such deaeration of the inside volume of the package is disadvantageous rather than advantageous since it may further increase the residuals because of tight adhesion of the film to the surface of the glass substrate. This further increases the costs and time required for the chemical washing process.

SUMMARY OF THE INVENTION

I. THE PROBLEMS TO BE SOLVED BY THE INVENTION

As described above, each of the prior-art techniques in which no gap is provided between each adjacent glass substrate has at least one of (1) the problem of surface yellowing and (2) the problem of the costly and time-consuming chemical washing process using a detergent or the like that considerably limits the production efficiency of the LCDs etc.

An object of the present invention is thus to provide an improved glass substrate package which overcomes all of the above-described problems in the prior-art techniques. That is, the present invention realizes high stacking efficiency (i.e. high efficiency in transportation and storage), and concurrently eliminates both of the problems of surface-yellowing and the costly and time-consuming chemical washing process carried out after unpacking and before processing of the glass substrate.

II. HOW TO SOLVE THE PROBLEMS

A glass substrate package according to the present invention is a package in which a glass substrate is packed and sealed with a film which does not dirty surfaces of the glass substrate. The glass substrate is typically a glass substrate to be used for a liquid crystal display.

Herein, a polyethylene terephthalate film is typically used as the film which does not dirty the surfaces of the glass substrate.

A laminated film may also be used as the film which does not dirty the surfaces of the glass substrate. In that case, the innermost one of the layers constituting the laminated film may be a polyethylene terephthalate layer. In addition, at least one of the layers constituting the laminated film may have a moisture-proof property. In that case, an aluminum layer

which is not the innermost layer may act as the layer having the moisture-proof property.

Further, it is preferable to deaerate an inside volume of the glass substrate package according to the present invention.

Herein, the film which does not "dirty" the surfaces of the glass substrate refers to a film (1) which leaves on the surfaces of the glass substrate no residuals of the film or only a few residuals that can be washed away through a physical washing process only, even if the film is pressed against the surface of the glass substrate by stacking of a plurality of packages etc., and (2) which does not have any bad influences on the surfaces of the glass substrate that may cause the glass substrate to require a chemical washing process (e.g. chemical reaction of the film material).

The above term "physical washing process" refers to a washing process which does not require use of any special detergents or agents, e.g., a washing process using only a jet of water or an ultra-sonic washing process. On the other hand, the term "chemical washing process" refers to a washing process which requires use of a special detergent or agent.

In addition, the "polyethylene terephthalate film/layer" in the present invention may contain a few impurities as far as it can still be called a "polyethylene terephthalate film/layer (a PET film/layer)" in an industrial sense.

Further, the term "laminated film" in the present invention refers not only to a laminated film in a strict sense which is made through a laminating process, but also to a layered film of any other type including a film made through a process of vapor deposition as far as it consists of superposed layers of two or more materials. In addition, the "aluminum layer" in the present invention includes a deposited layer of aluminum.

III. ADVANTAGEOUS EFFECTS OF THE INVENTION

Since the glass substrate is packed and sealed with the film which does not dirty the surfaces of the glass substrate in the glass substrate package according to the present invention, it is possible to solve both of the

problems of surface-yellowing and the costly and time-consuming chemical washing process carried out after unpacking and before processing of the glass substrate, while realizing high efficiency in transportation and storage of the glass substrates through direct stacking of a plurality of packages. Thus, the glass substrate packed in the glass substrate package according to the present invention requires only the physical washing process after unpacking and before processing thereof. This greatly reduces the time and costs required for the washing process down to a level much lower than those of the chemical washing process that has been indispensable so far. Such an advantageous effect is particularly important in the case of the glass substrate for the liquid crystal display which requires particular caution to eliminate scratches and dirt on the surfaces thereof.

The effect of preventing dirtying of the surfaces of the glass substrate can be further enhanced by using the laminated film as the film for the package of the present invention and providing the moisture proof property to at least one of the layers constituting the laminated film. This further reduces the time and costs required for the washing process.

In addition, the package according to the present invention using the film which does not dirty the surfaces of the glass substrate enables vacuum-packaging (i.e. packaging while deaerating the inside volume of the package) of the glass substrate. This is because the film used for the package does not leave on the surfaces of the glass substrate the residuals that require wash-off through the chemical washing process even if the film is strongly pressed against the surfaces. Such vacuum-packaging further improves the stacking efficiency, i.e., the efficiency in transportation and storage of the glass substrates. In addition, unfavorable displacement of the glass substrate within the package can be prevented when the vacuum-packaging is employed. This prevents the scratches due to effect of friction between adjacent glass substrates that cannot be totally blocked by the films.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a front view of a glass substrate package according to one embodiment of the present invention.

Figure 2 is a figure showing individual steps of an exemplary process for preparing the package shown in Figure 1.

DETAILED DESCRIPTION/PREFERRED EMBODIMENTS OF THE INVENTION

Now, exemplary embodiments of the present invention will be described in detail with reference to the accompanying drawings.

Shown in Figure 1 is a glass substrate package 1 according to one embodiment of the present invention. In the glass substrate package 1, a glass substrate 2 is packed and sealed with a polyethylene terephthalate film 3 (hereinafter, referred to as the "PET film 3"). In Figure 1, the PET film 3 is folded at the bottom edge of the glass substrate package 1. Provided near the right and left edges and the upper edge of the glass substrate package 1 are heat-sealed portions 4 and 5, respectively. It is desirable that the internal volume of the glass substrate package 1 has been deaerated.

Figure 2 shows individual steps of an exemplary process for preparing the glass substrate package 1 shown in Figure 1.

First, in the step of Figure 2A, the glass substrate 2 is inserted into a folded end of the PET film 3 in a long and continuous form. Herein, a heat-sealable material has been applied through a laminating process to inner surfaces of band-like portions 4' near the right and left edges of the PET film 3. Similarly, the heat-sealable material has also been applied through the laminating process to the inner surfaces of horizontal band-like portions 5'. The horizontal band-like portions 5' are arranged with predetermined intervals so that positions of two adjacent ones of the horizontal band-like portions 5' match when the PET film 3 is folded.

In the step of Figure 2B, a roller 6 having a pair of heated rollers 7 on opposite ends thereof rolls over the folded portion of the PET film 3

where the glass substrate 2 has been inserted. The roller 6 heat-seals the band-like portions 4' to form the heat-sealed portions 4 while squeezing the air out of the folded portion of the PET film 3.

In the step of Figure 2C, a heat-sealing bar 8 heat-seals the positionally-matched band-like portions 5' to form the heat-sealed portion 5. This step completes packing and sealing of the glass substrate 2 in the folded PET film 3. Herein, instead of carrying out the step of Figure 2C, the band-like portions 5' may be temporarily sealed at first leaving an unsealed portion and then completely sealed after deaerating the inside volume of the folded portion. This further improves the degree of deaeration of the inside volume of the glass substrate package 1.

Finally, in the step of Figure 2D, the formed glass substrate package 1 is cut off from the remaining portion of the PET film 3 in the long and continuous form. Then, in the present embodiment, the process returns to the first step shown in Figure 2A and a plurality of similar packages are formed in sequence.

Since the PET film 3 used in the above embodiment does not dirty surfaces of the glass substrate 2, a required level of the washing process for each glass substrate after unpacking and before processing thereof can be greatly lowered to a level of the physical washing process, while realizing high efficiency in transportation and storage of the glass substrates. The stacking efficiency (i.e. the efficiency in transportation and storage) of the package 1 can be further improved in the case where the degree of deaeration of the inside volume thereof is improved. In addition, such an improvement in the degree of deaeration prevents undesirable displacement of the glass substrate 2 within the package 1, and thus prevents each glass substrate 2 from being scratched under the effect of friction between adjacent glass substrates 2 that cannot be totally blocked by the PET films 3.

Although the above embodiment employs the heat-sealable material applied to the band-like portions on the inner surface of the PET film 3 to

pack and seal the glass substrate 2 using the heat-sealing technique, any other appropriate method such as a method using a double-sided tape may be alternatively used.

In an alternative of the above embodiment, a laminated film may be used in place of the PET film 3. Similarly to the PET film 3, the laminated film must be a film which does not dirty the surfaces of the glass substrate 2. In addition, it is desirable that at least one of layers constituting the laminated film has a moisture-proof property.

For example, the above laminated film may be a film consisting of a PET layer facing the glass substrate 2, an aluminum layer, and a protection layer such as a polypropylene layer laminated in this order through a laminating process. In this example, the aluminum layer having a moisture-proof property further prevents dirtying of the surfaces of the glass substrate 2. Also in this example, the required level of the washing process for each glass substrate after unpacking and before processing thereof can be greatly lowered to the level of the physical washing process, while realizing high efficiency in transportation and storage of the glass substrates. In addition, the same advantage as described above can be obtained in the case where the degree of deaeration is improved.

Herein, a process of vapor deposition may be used in place of the laminating process to provide the aluminum layer in the above example.

In the above embodiment, the PET film is used as a typical example of the film which does not dirty the surfaces of the glass substrate. Now, explained below are results of experiments that prove effectiveness of the PET film as the film which does not dirty the surfaces of the glass substrate.

The experiments were conducted on eight commercially-available films.

The experiments were carried out through the following process. First, nine samples were prepared for each of the eight films. Each sample was prepared by attaching a piece of a film onto a part of one surface of a

glass substrate. Three of the nine samples were kept at room temperature for one day, another three samples were kept at a temperature of 60°C for an hour, and the remaining three samples were kept at a temperature of 60°C for one day. Thereafter, the film was removed from each sample. Then, steam was blown over the entire surface of the glass substrate of each sample to compare by visual observation a condition of the steam on the portion where the film had been attached and that of the portion where the film had not been attached. According to the visibility of marks of the film, a degree of surface dirtiness of the portion where the film had been attached was evaluated with six grades (i.e. grades A-F as explained below). Next, one of each of the three glass substrates kept under the same condition in the above step was washed in 50°C pure water through an ultra-sonic washing process for four minutes, rinsed and dried (condition "I"). Another one of the three glass substrates was washed in a 50°C solution of a typical alkaline detergent used for washing glass substrates through an ultra-sonic washing process for four minutes, rinsed and dried (condition "II"). The remaining one was washed in a 50°C solution of the same alkaline detergent through an ultra-sonic washing process for one minute, rinsed and dried (condition "III"). Then, the degree of surface dirtiness of each glass substrate was evaluated again in the same way as described above with the six grades (i.e. the grades A-F). The grades were determined according to the following standards:

A: Completely no marks of the film were observed;

B: Only a faint mark was observed when extreme attention was paid;

C: An outline of the film was barely observed;

D: The outline of the film was clearly observed when viewed from the opposite side of the glass substrate;

E: The outline of the film was clearly observed from either side of the glass substrate; and

F: A mark of the entire film was clearly observed from either side of the glass substrate.

In addition, the grade B' in Table 1 below is a grade for a state that relatively falls between the grades B and C.

The results of the above experiments are summarized in Table 1, with the particular films tested being shown in Table 2.

As shown in Table 1, each of the samples 1-3 to which PET films had been attached had only a few residuals of the films corresponding at least to the grade B' even before washing thereof (i.e. immediately after removal of the film). After the physical washing process using no detergent (corresponding to the condition "I"), the grade of each of the samples 1-3 was improved to the grade A. These results clearly show the effectiveness of PET films as films which do not dirty the surfaces of a glass substrate.

On the other hand, each of the samples 6 and 7, the samples of polyethylene films, which, to date, have been commonly-used as films for protecting the surfaces of glass substrates, showed remarkably many residuals of the film corresponding to the grade E before washing thereof (i.e. immediately after removal of the film). Moreover, even after the chemical washing processes under the predetermined conditions (i.e. the conditions "II" or "III"), the grade was improved only to the grade C at most. Of course, the situation was even worse when the physical washing process was employed. Thus, glass substrates packed with polyethylene film will require a chemical washing process of even longer time to achieve the level required for use of the substrate to produce an LCD or the like where surface clearness of the glass substrate is especially important. This will undesirably increase the time and costs required for the washing process, and thus considerably limit production efficiency of the finished product such as an LCD. The same applies to the polyolefin film used for the sample 8.

As for biaxially-oriented polypropylene films used for the samples 4 and 5, the film of the sample 4 achieved surface clearness as good as that of

the PET films. However, the film of sample 5 only achieved surface clearness at the same level as those of the polyethylene films and the polyolefin film.

As mentioned above, the above results of the experiments have proven the effectiveness of the PET film as a film which does not dirty the surfaces of a glass substrate. In addition, it will be evident that the laminated film used in the aforesaid alternative having a PET layer as the innermost layer thereof is also effective according to the above results.

While the present invention has been described above in detail with reference to the preferred embodiments and alternatives thereof, those embodiments and alternatives are mere examples. That is, the scope of the present invention is to be defined based only on the claims set forth below.

TABLE 1

Sample No.	Material	Surface	Room Temperature, 1 day aging			60°C, 1 hour aging			60°C, 1 day aging		
			I	II	III	I	II	III	I	II	III
1	PET	side A	B→A	A→A	A→A	B→A	B→A	B→A	B'→A	B→A	B→A
		side B	B→A	A→A	A→A	B→A	B→A	A→A	B'→A	B→A	B→A
2	PET	side A	B→A	B→A	A→A	B→A	A→A	A→A	B'→A	B→A	B→A
		side B	B→A	A→A	B→A	B→A	A→A	B→A	B→A	B→A	B→A
3	PET		B→A	B→A	B→A	B→A	B→A	A→A	B'→A	B→A	B→A
4	OPP		B→A	A→A	A→A	B→A	A→A	B→B	B'→A	C→A	B→A
5	OPP	side A	E→D	D→B	D→B	F→F	F→D	F→D	F→F	F→E	F→E
		side B	--	--	--	--	--	--	--	--	--
6	polyethylene		E→D	E→C	E→C	E→E	E→D	E→D	E→E	E→E	E→E
7	polyethylene		E→E	E→D	E→C	E→E	E→E	E→C	E→D	E→E	E→D
8	polyolefin		E→E	E→B	E→C	E→E	F→D	F→D	F→F	F→E	F→D

TABLE 2

Sample No.	Material	Surface Finishing	Vendor	Product Name (Film)
1	PET	side A: corona discharge finishing side B: none	Futamurakagakukougyou	FE2001 #12
2	PET	side A: corona discharge finishing side B: none	Touyoubouseki	E5100
3	PET		Toray	Lumirror T60
4	OPP (biaxially-oriented polypropylene film)		Touyoubouseki	P2002
5	OPP (biaxially-oriented polypropylene film)	side A: corona discharge finishing side B: none	Futamurakagakukougyou	FOR #20
6	polyethylene		Sekisuikagaku kougyou	Protect tape #624S
7	polyethylene		Sekisuikagaku kougyou	Protect tape #624C
8	polyolefin		Sanekaken	PAC-2-50THK